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Improving the performance of manufacturing sector-lean methodology and its impact

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ABSTRACT: *Productivity improvement techniques can be applied effectively in enterprises of any size, from one-person companies to corporations with thousands of staff. The majority of the techniques were first seen in mass-production operations but the benefits they can yield in SMEs is not to be underestimated. Many organizations are nowadays interested to adopt lean manufacturing strategy that would enable them to compete in this competitive globalization market. In this respect, it is necessary to assess the implementation of lean manufacturing in different organizations so that the important best practices can be identified. This paper describes the development of key areas which will be used to assess the adoption and* ***implementation*** *of lean manufacturing practices. Lean manufacturing is often seen as a set of tools that reduce the total cost and improve the quality of manufactured products. The lean management philosophy is one which targets waste reduction in every facet of the manufacturing business. This paper will review the current literature and describe how lean methodology can provide a framework mechanism for environmentally sustainable manufacturing sectors.*

Keywords: *Lean manufacturing, Manufacturing, Performance improvement, Tools and techniques*

I. INTRODUCTION

Many of the ideas behind what is now termed lean thinking were originally developed in Toyota's manufacturing operations. The Toyota Production System spread through their supply base during the 1970s and their distribution and sales operations during the 1980s. The term 'lean manufacturing' was popularised in the book, The Machine that Changed the World by Womack, Jones and Roos[1], which illustrated for the first time the significant performance gap between the Japanese and western automotive industries. It described the key elements accounting for this superior performance as lean production - 'lean' because Japanese business methods used less of everything (human effort, capital investment, facilities, inventories and time) in manufacturing, product development, parts supply and customer relations. Besides auto industry, Lean production also extends to machinery manufacturing, electronics, consumer goods, aerospace and shipbuilding and becomes another milestone of modem production methods after mass production methods. In 21st century the application of lean thinking obtains advancements and has turned into a new generation guidance thinking of management revolution. [2] The main purpose of implementing lean manufacturing is to increase productivity, reduce lead time and cost and improve quality thus providing the up most value to customers. There are many descriptions regarding lean manufacturing. Lean manufacturing means eliminating wastes by identifying on value added activities thorough out the supply chain. The five fundamental Lean principles are to specify value from the point of view of customer, identify the value stream, make the identified value flow, set the pull system which means only make as needed and finally perfection in producing what the customer wants and by when it is required in the right quantity with minimum waste. [3]
The key lean-thinking principles include the following.

a. Recognise that only a fraction of the total time and effort in any organisation actually adds value for the end customer. By clearly defining value for a specific product or service from the end customer's perspective, all the non-value activities - or waste - can be targeted for removal. For most production operations only 5% of activities add value, 35% are necessary non-value adding activities and 60% add no value at all. Eliminating this waste is the greatest potential source of improvement in corporate performance and customer service.

b. Few products or services are provided by one organization alone, so waste removal has to be pursued throughout the whole value stream - the entire set of activities across all the firms involved in jointly delivering the product or service. New relationships are required to eliminate inter-firm waste and to effectively manage the value stream as a whole.
c. Instead of managing the workload through successive departments, processes are reorganised so that the product, or design, flows through all value-adding steps without interruption. Obstacles to uninterrupted flow are identified and removed using the toolbox of lean techniques. Activities across each firm are synchronized by pulling the product or design from upstream steps at just the time when required to meet the demand from the end customer.
d. Removing wasted time and effort represents the biggest opportunity for performance improvement. Creating flow and pull starts with radically reorganising individual process steps but the gains become truly significant as these process steps link together. As this happens more and more layers of waste become visible and the process continues towards the theoretical end point of perfection, where every asset and every action adds value for the end customer. In this way, lean thinking represents a path of sustained performance improvement - and not a one-off programme.

II. WHAT IS LEAN MANUFACTURING?

Lean Manufacturing can be defined as: Lean manufacturing or lean production, which is often known simply as "Lean", is the optimal way of producing goods through the removal of waste or "Lean manufacturing is the system which aims in elimination of the waste from the system with a systematic and continuous approach" OR Lean Manufacturing is an operational strategy oriented toward achieving the shortest possible cycle time by eliminating waste. Lean manufacturing techniques are based on the application of five principles to guide management's action toward success.[4]

2.1. Value

In lean production, the value of a product is defined solely by the customer. Identifying the value in lean production means to understand all the activities required to produce a specific product, and then to optimize the whole process from the view of the customer.

2.2. Continuous improvement

The transition to a lean environment does not occur overnight. A continuous improvement mentality is necessary to reach your company's goals. The term "continuous improvement" means incremental improvement of products, processes, or services over time, with the goal of reducing waste to improve workplace functionality, customer service, or product performance.

2.3. Customer focus

A lean manufacturing enterprise thinks more about its customers than it does about running machines fast to absorb labour and overhead. Ensuring customer input and feedback assures quality and customer satisfaction, all of which support sales.

2.4. Perfection

The concept of perfection in lean production means that there are endless opportunities for improving the utilization of all types of assets. The systematic elimination of waste will reduce the costs of operating of an enterprise and it fulfill customer's desire for maximum value at the lowest price.

2.5. Focus on waste

The aim of Lean Manufacturing is the elimination of waste in every area of production including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products and less space to become highly responsive to customer demand while producing top quality products in the most efficient and economical manner possible.

III. PERCEIVED BARRIERS TO TACKLING PRODUCTIVITY IMPROVEMENTS

Various concerns may deter SMEs from implementing productivity improvements [5]. The following are among them.

3.1. **Cost** Perhaps the natural for an SME is to react by saying, 'We just can't afford it', but it may be better to focus on cost savings that result from potential improvements when considering a productivity improvement drive. The question should be 'Can we afford not to improve productivity?' View short-term cost as a longer-term investment to reduce more significant costs to the organization.

3.2. Employee resistance to change Even though SMEs are identified as having people who are open to change, the reverse can also be true. In particular, if certain employees have been with the SME since the organization was founded, it may be difficult to persuade them that the way they have always done things is not in fact the most effective way of working. From the perspective of the SME, this way has been successful, so it may be hard to accept that these productivity improvements are not just the latest management fad.

3.3. Personnel resource It can be difficult to release employees for training in an SME if they are multi-skilled and cannot easily be covered for by other staff. Larger companies may have staff dedicated to productivity improvement, who can dedicate their time to training and implementing productivity improvement initiatives. One way to get around the difficulty in SMEs is for management to lead by example. If other members of staff see them initiating and implementing improvements as a part of their job, they may get an understanding of what the organization is trying to achieve.

3.4. Specialist knowledge larger companies may have staff who are dedicated to productivity improvement and have gained the knowledge necessary to champion improvement initiatives. It then becomes vital for senior staff to become acquainted with at least the basic principles of some of the productivity improvement tools and techniques outlined later in this report.

3.5. Activities not standardized larger companies will tend to have industrial engineering departments that have formulated standard operating procedures (SOPs) for each process. This may not be the case for SMEs. A central theme of continuous improvement or kaizen is that the starting point is always a well-documented SOP. The action of drawing up standard procedures itself can identify areas for potential improvements.

IV. LEAN MANUFACTURING TOOLS

The foundation of lean manufacturing [6] includes the following tools:

4.1. Standardized work

Operations are organized in the safest, best known sequence using the most effective combination of resources. Jobs are broken down into elements and examined to determine best and safest method for each. The standard is then established, taught and sustained by repetition.

4.2. Workplace Organization/5S

Various housekeeping activities are often used for continuous improvement. The workplace organization activities are:

1. Sort-out - what is required and not required;
2. Set in order - a place for everything and everything in its place;
3. Shine / cleanliness - cleaning all the work places with an eye of preventive maintenance;
4. Standardize - the system throughout the organization;
5. Sustain - the efforts with self-discipline.

4.3. Visual factory (VF)

Visual Factory provides real-time view of manufacturing process, and increases production output. The Visual Factory provides a real-time communications network to monitor and collect information on the progress and quality of orders. It communicates status and progress up and down the manufacturing line and to all levels of management. It also helps to provide data and feedback on hidden re-work costs at each step in the process. The consolidation of data sources into analysis tools and reports grants executives and managers forecasting capabilities and sales and financial management predictability.

4.4. Point of use storage

Locate all parts raw material, tools and fixtures as close as possible to where they are being used.

4.5. Kanban

A Kanban system is an information system that controls the required parts at the required time. The word Kanban literally means visible record. In the Kanban system, which has been employed as a JIT production control technique since the mid-1970s, flow is controlled by the use of cards. When implemented correctly, JIT and Kanban can result in reduced inventory and higher efficiency in a manufacturing system.

The Toyota system is a two-card system; it uses so-called move kanbans (also known as conveyance or withdrawal kanbans) and production kanbans. For example, imagine work centre B produces subassemblies using parts drawn from a parts container at B’s inbound stock point. A move Kanban – one of which is found in each such inbound container – is removed from the container when it is exhausted and is taken to the outbound stock point of the work centre (let it be work centre A) immediately upstream. A full container of the same parts is then found there. The production Kanban – one of which is found in each such outbound container – is removed from this full container. The move Kanban from the exhausted container is placed in the full container, authorizing its transport from A’s outbound stock point to B’s inbound stock point. The production Kanban is then placed near work centre A to authorize production of another container of parts at A for B. When work centre A has finished producing a full container of parts, the production kanban is then placed in this container, which is deposited at A’s outbound stock point.

4.6. Kaizen

Kaizen is a Japanese word for continuous improvement. Kaizen is the process of identifying and eliminating wastes as quickly as possible at the lowest possible cost.

Kaizen is a Japanese word meaning gradual never-ending improvement in all aspects of life. It represents a Japanese approach to improvement and can be interpreted as continuous improvement in all areas. Kaizen is at the heart of quality improvements in Japanese companies.

The classical Western approach to improvement has been one of technology innovation. Large sums of money have been spent on new equipment and systems using the latest technology to give step changes in performance. This has led to dramatic improvements but they have typically not been standardized and maintained. Kaizen, on the other hand, relies on an investment in people. It is a continuous series of small improvements made on existing equipment or systems by the people who actually work in that area. It does not rely on specialist involvement but can be used to support those directly involved in making the improvement. Important aspects of kaizen are the standardization and maintenance of the improvement, which are as crucial to the process as the improvement itself. Improvements must become standardized and maintained until further improvements are made [7]

There is a structured approach to kaizen-based improvements and each step must be followed to ensure lasting improvement. The approach proceeds in the following steps.

1. Define the area for improvement
2. Analyze and select the appropriate problem
3. Identify its causes
4. Plan countermeasures
5. Implement countermeasure
6. Confirm the result
7. Standardize

Techniques used in facilitating kaizen include the following:

1. Zero defects
2. just-in-time
3. Kanban
4. Total productive maintenance
5.5S

V. STATISTICAL PROCESS IMPROVEMENT

A key tool supporting lean implementation are probabilistic and statistical methods required to improve the quality of products and processes. Six Sigma methodologies incorporate a toolbox of statistical process improvement (SPI) techniques that can effectively drive sustainable process improvement. It is crucial to identify the true root causes of waste and SPI insures that those root causes and the corrective actions will truly impact those wastes significantly. Statistical Process Control (SPC) Charts can be an important part of both a Management Operating System and the 5S process in the foundry to drive improvements in both process control and environmental control. SPI can be used for reducing foundry scrap with resulting cost and sustainability benefits. Designed experiments can be used to make process improvements as well as environmental improvements. SPI techniques can be powerfully used to develop better understanding of material and energy usage, production line productivity, and environmental impacts. SPC charts can be used for controlling electrical usage, or improving emissions.[8]

VI. CONSERVATION OF ENERGY

As stated in the introduction, manufacturing operations are energy intensive. While on-site generation of greenhouse gases through the heat generated via the burning of coke or natural gas is a major concern for foundries, data from the U.S. Energy Information Administration Environment website identifies the generation of electricity as the number one source for foundry greenhouse gas emissions. Energy use is typically not a metric that is employed in manufacturing systems design. The efficient conversion of a fuel to desired output is diminished in the many phases of electrical generation, transmission, and use. Thus, efforts at controlling and reducing electrical energy usage in the foundry have magnified environmental benefits and should be targeted in lean and green efforts.

Techniques to improve energy consumption used in conjunction with the other waste reduction techniques contained in the lean toolset, not only provide energy reduction, but also improve costs. Tracking energy flows through the system using a Green Value Stream Map is one technique that can be used to reduce consumption. An example is compressed air, often used in manufacturing sectors [9]

VII. INNOVATIVE TECHNOLOGIES

While lean manufacturing techniques can make improvements in a foundry's economic and environmental sustainability, innovative technologies may be required to make large breakthroughs. Emissions requirements have grown considerably more restrictive for foundries with the enactment of the 1990 Clean Air

Act. While there are many possible theoretical solutions for reducing foundry emissions, acceptable solutions must also be financially sustainable. To preserve the viability of foundries, both researchers and industry have developed a number of approaches to decrease emissions from foundries.

Strategies range from reformulating chemistries of organic binders to developing processes for conditioning sand to lower the amount of released organic compounds and reduced binder levels by better core blowing. Two specific innovative technologies, Advanced Oxidation and OP-AID, have proven to both improve cost and reduce environmental impacts.[10]

Identifying opportunities for innovative technologies can be fostered through the Management Operating System, Green Value Stream Mapping, and 7R.[11]

VIII. CONCLUSIONS

This paper provides a broad perspective on combining lean manufacturing methods with environmental sustainability to assist manufacturing sector in remaining competitive. Two specific technologies which both improve cost and reduce environmental impact for foundries were reviewed, demonstrating that environmentally sustainability solutions can also reduce operating costs. A set of proven, effective lean tools and techniques that can assist in their sustainability efforts were reviewed.

The following principles were recognized as essential for continuous improvement.

1. Traceability In order to identify root causes and prevent them recurring there must be a system in place to trace defects back to their source. In assembly manufacturing, this normally means tracing components by lot and vendor back to the problem assembly stage. In process manufacturing, this means tracing control conditions by critical process step for the lots affected by the defect.
2. Design of experiments The most effective way of improving process steps in order to increase yield, shorten cycle time or make the process more robust.
3. Stop-in-time When defects are detected on the production line; the defective material must be stopped immediately. If a second, similar defect is discovered the process step must be stopped immediately and corrective action taken. This prevents adding waste to the defective product and prevents production of further defects.
4. Root cause detection Statistical data collection is a method of identifying root causes. The five Ws (who, what, where, when, why) and two Hs (how, how much), also help track down the root cause of any problems in complex production environments.

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